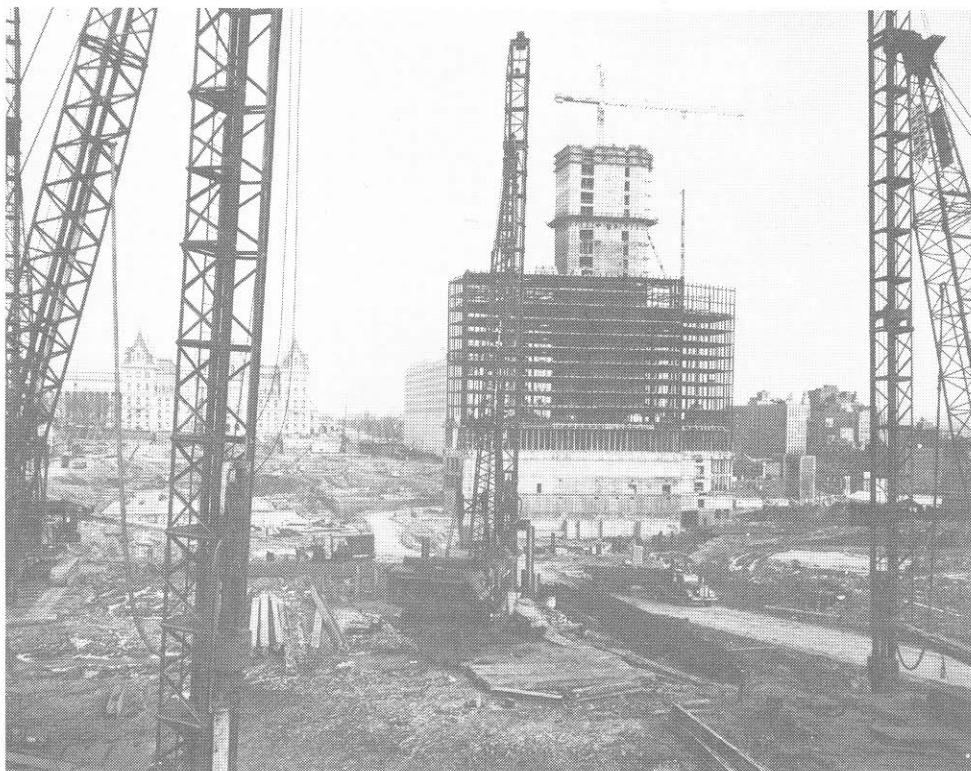


Engineering Geology Classification of the Soils of the Albany, New York 15 Minute Quadrangle

by
ROBERT H. FICKIES
and
PETER T. REGAN



**NEW YORK STATE MUSEUM
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*The University of the State of New York
The State Education Department
Albany, NY 12230*

ERRATA ON MAPS

- Map 1. Engineering Geology Classification of the Soils of the Albany, New York 15 Minute Quadrangle—The Legend, soil classification Unit II-2 should read: "poorly graded sands."
- Map 2. Geologic Hazards and Thickness of Overburden of the Albany, New York 15 Minute Quadrangle—The Legend, line 5 should read: "Area having potential for wind erosion and sloughing if stripped of surface cover."

Cover photo:

Pile driving operations during construction of the Governor Nelson A. Rockefeller Empire State Plaza in Albany, New York (1967). More than 20,000 steel piles were driven through relatively soft glacial lake clays to provide a secure bearing for the buildings on firm glacial till.

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New York State Geological Survey

ABSTRACT

The engineering classification of the soils of the Albany, N.Y. 15 minute quadrangle, presented on a 1:24,000 scale planimetric base map, uses the Unified Soils Classification System (USC) and groups the complex glacial and glacio-fluvial deposits of the region into eight distinct units that are defined by gradation and cohesion characteristics or special engineering considerations. The important engineering properties of each of the soil units include moist bulk density, liquid limit, plastic limit and the most common USC designations. A companion map at the same scale displays the thickness of the soil deposits and potential geologic hazards in the region. Geologic hazards include landsliding, sinkholes, wind erosion and sloughing.

INTRODUCTION

The surficial geology of the Albany, New York 15 minute has been studied and mapped in great detail over the past 10 years by Robert J. Dineen (Dineen, 1981). His work reveals that the Albany area has a complex glacial and post-glacial history recorded within its surficial deposits. He recognizes several advances of glacial ice and formation of several major proglacial lakes, the most significant being Glacial Lake Albany, that at one time occupied the entire northeastern half of the quadrangle. Dineen recognized and mapped no less than two dozen generic, lithofacies soils in the area based upon age and mode of deposition. Many of these generic soil units exhibit similar textural and structural properties that could be classified into categories more readily adaptable to engineering uses than the original detailed generic units.

In 1981, the New York State Geological Survey with the cooperation of the United States Geological Survey, initiated a project to demonstrate the feasibility of deriving an engineering classification of surficial materials in the glaciated Northeast from glacial geology maps and developing an economical means of publishing these data. This report with two maps is the result of this study. The maps are a derivative of the original mapping by Dineen to be published in the future.

- Dense glacial tills
- Lake deposits
- Organic deposits
- Poorly graded sands
- Sand and gravel
- Silty sand and gravel
- Flood-prone silty sand and gravel
- Manmade fill

The first six of these units are identified by their gradation and cohesion characteristics as defined by the Unified Soils Classification (U.S.C.) (U.S. Dept. of Defense, 1968). It is not the purpose of this report to explain the U.S.C. as it is assumed that many users of these maps will have some knowledge of its use. A brief explanation of the U.S.C. is contained in the Appendix. The seventh unit, flood-prone silty sand and gravel, is essentially the same material as the sixth unit. However, such flood-prone areas do require special planning or engineering consideration, and alluvial or fill deposits that are subject to periodic flooding by adjacent streams are readily distinguishable as separate units. Therefore, we present them on the map as a distinct unit. These soils generally have a seasonally high water table and consequently should, for the most part, be avoided as sites for permanent structures.

The eighth unit, manmade fill, implies no textural, compositional, or engineering classification. Fill deposits may be derived from excavation of nearby similar soil, or may be transported some distance and be completely dissimilar to adjacent or underlying deposits. Fill may contain varying amounts of ash, cinders, rubble, stone, and other debris, or it may be composed entirely of natural soils. Fill deposits are shown where they occur as mappable units, thick enough to have an influence on construction in the area.

SCOPE

The study encompasses all the area included in the Albany, New York 15 minute quadrangle. The area includes the entire City of Albany and parts of the towns of Bethlehem, Coeymans, Colonie, East Greenbush, Guilderland, New Scotland, Schodack and Westerlo. The geologic units investigated include all unconsolidated materials occurring above bedrock. The study was designed to rely primarily on existing data to develop an engineering geology soils classification map of the area.

THE ENGINEERING SOIL UNITS

The unconsolidated earth materials overlying bedrock (i.e., soils in the engineering sense) within the Albany 15 minute quadrangle are grouped into eight map units, each representing a unique soil type. These units are:

Properties of the Engineering Soil Units

Table 1, the Properties of the Engineering Soil Units Chart indicates the range of engineering properties (i.e., moist bulk density, liquid limit, plastic limit, and most common U.S.C. designations), drainage characteristics, and engineering use characteristics for each of the soil units (with the exception of Manmade Fill). The data and observations presented in this table are derived from several sources including information developed specifically for this study, conclusions made by others working in the area, data presented in a New York State Department of Transportation report (Fleckenstein, 1974), and from general engineering observations made and widely accepted for soils with similar engineering properties. Table 1 is to be used as a general guide only because soil characteristics and conditions may vary from site to site.

THE MAPS

Two maps were designed to provide as much easily understandable data as possible while keeping cartographic and printing costs as low as possible. Each map is presented on a planimetric base (New York State Department of Transportation, 1974). The high cost of multicolor printing was avoided by the use of a two-color design with screened patterns. Map users may wish to consider coloring certain units to highlight them.

The Soils Classification Map

This map, titled "Engineering Geology Classification of the Soils of the Albany, New York 15 Minute Quadrangle," depicts the areal extent of each of the eight engineering soil units, and areas where bedrock occurs at or near the surface. Those areas shown to have bedrock at or near the surface generally have rock within three feet of the ground surface. This condition must be taken into consideration in any construction plans for those areas. This map is broadly subdivided into several areas, each with different "vertical sequence regions." The boundary lines, shown in red, are zones of transition between areas of different sequences of soil units above the bedrock. Schematic sections that show typical vertical soil sequences from each region are presented along the right margin of the map. These sections give the map user a "best guess" of what sequence of soils he might encounter in drilling or excavating in an area.

Geologic Hazards and Thickness of Overburden Map

This map serves the dual purpose of delineating areas of potential geologic hazard and providing an estimate of overburden thickness. Within the Albany 15 minute quadrangle, geologic hazards are identified as:

- areas having potential for landsliding
- areas having potential for sinkhole development
- areas having potential for wind erosion or sloughing
- flood-prone areas (shown on the Soils Classification map).

Potentially the most serious geologic hazard in the Albany area is landsliding in the varved clays and silts that form the Glacial Lake Albany bottom-deposits. Most landsliding occurs where these deposits have been dissected by the post-glacial Hudson River and its tributary streams. By field and airphoto mapping of hundreds of active slides in the area (Dineen, 1981) and an

evaluation of the engineering properties of the lake clays we conclude that all clay slopes over 40 feet in relief with a slope of 12 degrees or greater should be considered marginally stable at best. These slopes have a potential for landsliding, particularly if either the surface contour or drainage is altered.

Landslides in the region have caused property damage, injury, and death since the early 19th century (Mather, 1843, Newland, 1915), and their frequency has increased as development of previously unaltered clay slopes has accelerated in the past few decades (Dunn and Banino, 1977). Many of the earlier, catastrophic slides in the region were triggered by the quarrying of clay for brick manufacturing from the base of unstable lake clay slopes. Many of today's slides are the result of highway or building construction. Types of adverse activity on marginally stable slopes generally fall into three categories: loading of the top, unloading of the toe, or altered drainage patterns resulting in a raising of the water table. The placement of fill at the upper edge of clay slopes in an attempt to increase the size of building lots has triggered many slides in the area. Quite commonly, runoff from parking lots or driveways is directed over these slopes, increasing pore water pressure which decreases slope stability.

Sinkholes

Sinkholes occur in soils overlying the Devonian Onondaga and Helderberg Group limestone outcrop belts extending from the south-central to the north-central borders of the quadrangle. Much of this area is characterized by a shallow till cover over bedrock. Open joints in bedrock often are related to soil collapse and development of sinkholes of varying sizes. Sinks observed in the Clarksville area range from several feet to several hundred feet in length. Many new sinks open as a result of the rerouting and concentration of surface drainage associated with road, parking lot, or building construction. It should be noted that sinkhole development in the area rarely is the large, catastrophic type of collapse associated with karst terraines such as those found in Florida. Sink development generally is gradual, but periodically can accelerate during times of heavy rainfall. Small sinks that are recognized in their initial development stages can be controlled by rerouting surface drainage and the use of filter mats and designed fill.

Table 1. Properties of the Engineering Soil Units.

ENGINEERING UNIT	NAME	UNIFIED CLASSIFICATION*	LIQUID LIMIT	PLASTIC LIMIT	MOIST BULK DENSITY (g/cm ³)	PERMEABILITY		POTENTIAL FROST ACTION	RUNOFF
						NATURAL	COMPACTED		
I-1	Dense glacial tills	GM-GC, SM-SC, GP, SP, ML, CL-ML	15-35	NP-20	1.60-1.95	Semipervious	Semipervious to Impervious	Slight to High	Rapid to Slow depending on slope
I-2	Lake deposits	ML, CL, CL-ML, CH, MH	20-70	15-40	1.15-1.40	Semipervious to Impervious	Semipervious to Impervious	Medium to Very High	Rapid to Slow depending on slope
I-3	Organic deposits	DT, OL	25-40	5-20	1.45-1.75	Semipervious	Semipervious to Impervious	Slight to High	Slow
II-1	Poorly graded sands	SP, SM-SP, SW-SM	---	NP	1.45-1.65	Very Pervious to Pervious	Pervious	None to Very Slight	Moderate to Slow depending on slope
II-2	Sand & gravel	SW, GW, GP, SP, GW-GP, SW-SP, GP-GM, SP-SM	--	NP-10	1.45-1.65	Very Pervious	Pervious	None to Very Slight	Moderate to Slow depending on slope
II-3	Silty sand & gravel	GM, SM, GP-GM, SP-SM, GW-GM, SM-SC	0-20	NP-15	1.20-1.95	Pervious to Semipervious	Semipervious	Slight to High	Rapid to Slow depending on slope
II-3A	Silty sand & gravel, flood-prone	GM, SM, SP-GM, SP-SM, SW-SP	15-25	NP-15	1.25-1.55	Pervious to Semipervious	Semipervious to Impervious	Slight to High	Slow

*Most common groups in bold letters

INFILTRATION	OVERALL DRAINAGE	POST COMPACTION SHEAR STRENGTH COMPRESSIBILITY		SLOPE CONDITIONS	SUITABILITY AS CONSTRUCTION MATERIAL
Good to Poor depending on percentage of fines and compaction	Good to Poor	Good to Fair Negligible		Rock may occur, seepage, sloughing and erosion are common. Flat slopes or slope protection may be required.	Soils are generally well-graded but subgrades are usually wet and sticky. Piling and drilling will encounter stoney and bouldery materials. Earthwork may be rockwork. Rock elevations should be profiled where depth to bedrock may affect design or construction.
Slow	Moderately Good to Poor	Fair	Medium	Cut slopes are stable in upper brown oxidized layers and unstable in underlying wet material. Slips and slides are very common. (See Geologic Hazards Map.)	Materials are fair when dry and poor to very poor when wet. Subgrades may be sticky and plastic and unsuitable materials will occur. Settlement and stability problems are very common. Depending on clay content, material may shrink when dry and swell when wet.
Slow	Poor	Poor	Medium	Cut slopes are not practical.	Must be removed and replaced. Underlying materials are variable. Excavations will be below the water table. Depth of unsuitable material must be determined.
Cut slopes are not practical.	Excessive to Good	Good	Very Low	Local seepage and sloughing are common. Erosion control measures are necessary. Normal slopes are stable.	Thicker deposits are dry most of year. Thinner deposits may be above wet silts and clays. Cut subgrades may be wet with sticky silts and clays. When significant to design or construction , the seasonally high water table must be located.
Rapid	Excessive to Good	Excellent	Negligible	Local seepage and sloughing are common. Erosion control is necessary in sandier units. Normal slopes are stable.	These are very good materials which dry easily. Water must be added for proper compaction. When significant to design or construction, the water table must be located. Low spots may contain muck or other unsuitable material.
Rapid to Moderate depending on percentage of fines	Good	Good	Low to Negligible	Local seepage and sloughing will occur. Erosion control is necessary in sandier units. Normal slopes are generally stable.	These are generally good materials although water may be required for compaction. When significant to design or construction, the water table must be located. Low spots may contain muck or other unsuitable material.
Slow	Moderately Good to Poor	Good	Low to Negligible	Cut slopes will be subject to severe seepage and sloughing. Cuts are not practical on flood-prone areas. Temporary cuts require dewatering and shoring.	Excavations in these poor materials will be permanently or seasonally ponded. Alluvial fan phases will generally dry by summer. When significant to design or construction, highest flood elevation and water table must be located. Recent alluvial may cover organic material.

Wind Erosion and Sloughing

The poorly graded, fine sands covering much of the northern and eastern parts of the quadrangle are primarily wind-blown beach deposits (Donahue, 1977). When these sands are stripped of their vegetative cover, as during construction activities, they can be transported by moderate winds. Occasionally, minor sandstorms have occurred in the Guilderland-Colonie areas causing abrasion damage and migration of dunes across highways. Construction projects also have faced the problem of severe sloughing and collapse of slopes in the sands during rainstorms.

Thickness of Overburden

The isopach lines (lines drawn through points of equal thickness) are based upon bedrock elevation data taken from hundreds of water wells and exploratory borings, and numerous refraction seismic lines. The contour interval for these isopach lines is variable with increasing overburden thickness. Areas of bedrock at or near the surface (0 to 3 feet overburden thickness) are shown. Isopachs also are drawn at 15, 25, 50, 100 and 200 feet. We adopted this technique to define more closely areas of relatively shallow bedrock so that engineers planning foundation excavation may be alerted to shallow bedrock conditions.

ACKNOWLEDGMENTS

The study was done in cooperation with the United States Geological Survey, Earth Sciences Assistance Office, (Grant Number 14-0B-01-G-702).

A study of this type that relies primarily upon a large bank of existing data cannot be successful without the willing cooperation of many individuals and organizations. The New York State Department of Transportation's Soil Mechanics Bureau, under the direction of Lyndon H. Moore, opened their doors and file cabinets for us, and Bureau Engineers Richard H. Burns and Edward Fernau shared with us their knowledge gained from many years of working with the soils of the Capital District. John B. Fleckenstein's report "Engineering Guide to the Soil Series of New York" (NYSDOT 1974) proved invaluable to our work.

The Albany County Soil and Water Conservation District provided useful information, as did several private engineering firms including Smith and Mahoney Engineers and Hoffman Engineering.

Luanne Wheeler spent many hours searching for and assembling data, and Karen Bosher spent many hours in microcomputer programming for the project. Jack

Skiba provided expert advice in map design and layout. The maps were drafted by Martha Costello.

Finally, this work would not have been possible without Bob Dineen, whose extensive knowledge and very accurate maps of the surficial geology of the area was a constant source of data.

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APPENDIX

A BRIEF DESCRIPTION OF THE UNITED SOIL SYSTEM

The Unified Classification System is an engineering soil classification derived from the Air-Field classification developed by Casagrande.

The system incorporates the textural characteristics of a soil into the engineering classification. All soils are classified into 15 groups, each group being designated by two letters. These letters are as follows: G-gravel, S-sand, M-nonplastic or low plasticity fines, C-plastic fines, Pt-peat, humus and swamp soils, O-organic, W-well graded, P-poorly graded, L-low liquid limit, H-high liquid limit.

GW and SW Groups

These groups comprise well-graded gravelly and sandy soils which contain less than 5% of nonplastic fines passing a #200 sieve. Fines that are present must not noticeably change the strength characteristics of the coarse grain fraction and must not interfere with its free-draining characteristics. In areas subject to frost action the material should not contain more than about 3% of soil grains smaller than 0.2 millimeters in size.

GP and SP groups

These groups are poorly graded gravels and sands containing less than 5% nonplastic fines. They may consist of uniform gravels, uniform sands, or nonuniform mixtures of very coarse material and very fine sand with intermediate sizes lacking. Materials of this latter type are sometimes referred to as skip-graded, cap-graded, or step-graded.

GM and SM Groups

In general, these groups include gravels or sands that contain more than 12% of fines having little or no plasticity. Gradation is not important and both low grade and poorly graded materials are included. Some sands and gravels in these groups may have a binder composed of natural cementing agents so proportioned that the mixture shows negligible swelling or shrinkage. Thus, the dry strength is provided by a small amount of soil binder or by cementation of calcareous materials or iron oxide. A fine fraction of uncemented materials may be composed of silts or rock flour types having little or no plasticity, and the mixture will exhibit no dry strength.

GC and SC Groups

These groups comprise gravelly or sandy soils with more than 12% of fines that exhibit either low or high plasticity. Gradation of these materials is not important. Plasticity of the binder fraction has more influence on the behavior of the soils than the variation in gradation. A fine fraction is generally composed of clays.

ML and MH Groups

These groups include predominately silty materials and micaceous or diatomaceous soils. An arbitrary division between the two groups has been established with a liquid limit of 50. Soils in these groups are sandy, clayey silts or organic silts with relatively low plasticity. Also

included are loessial soils and rock flours. Micaceous and diatomaceous soils generally fall within the group, but may extend into the ML group when their liquid limit is less than 50. The same is true for certain types of kaolin clays and some illite clays having relatively low plasticity.

CL and CH Groups

The CL and CH groups embrace clays with low and high liquid limits respectively. They are primarily inorganic clays. Low plasticity clays are classified as CL and are usually lean clays, sandy clays, and silty clays. The medium plasticity and high plasticity clays are classified as CH. These include fat clays, gumbo clays, certain volcanic clays and bentonite.

OL and OH groups

The soils in these groups are characterized by the presence of organic matter including organic silts and clays. They have a plasticity range that corresponds to the ML and MH groups.

Pt Group

Highly organic soils that are very compressible have undesirable construction characteristics and are classified in one group with the symbol Pt. Peat, humus, swamp soils with a highly organic texture are typical of the group. Particles of leaves, grass, branches or bushes and other fibrous vegetable matter are common components of these soils.

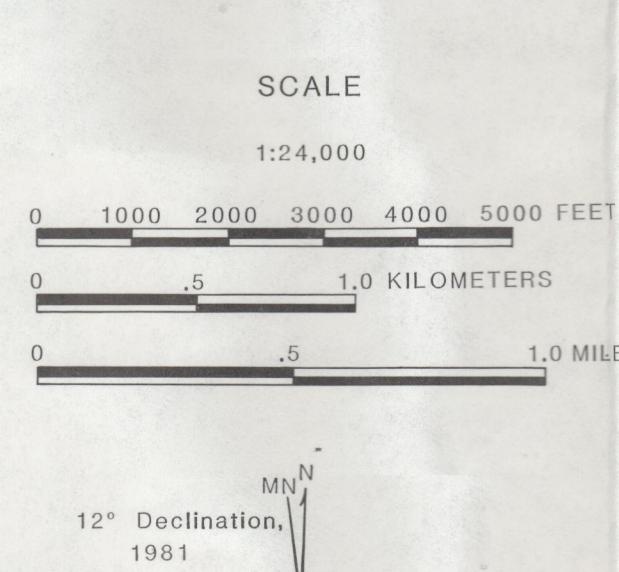
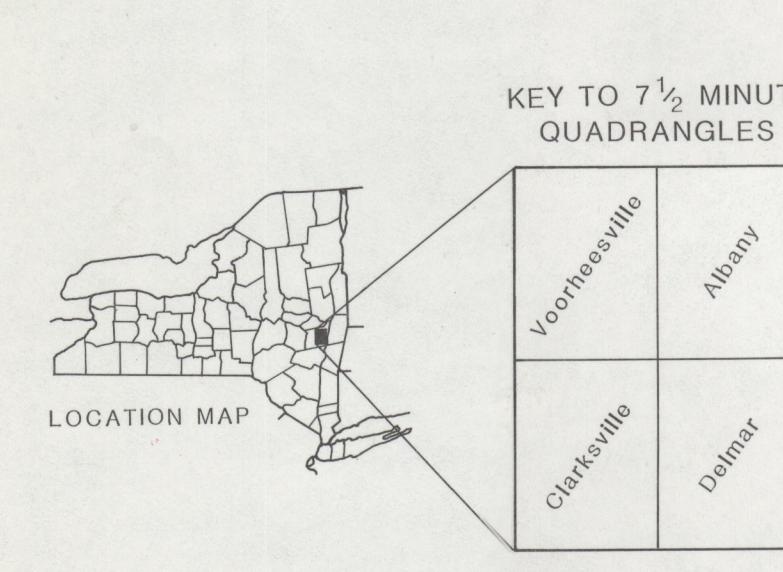

Borderline Classification

Soils in the GW, SW, GP and SP groups are non-plastic materials having less than 5% passing the #200 sieve, while GM, SM, GC, and SC soils have more than 12% passing the #200 sieve. These coarse grain materials containing between 5% and 12% of fines are classified as borderline and are designated by the dual symbol such as GW-GM. Similarly, coarse grain soils that have less than 5% passing the #200 sieve, but are not free-draining or in which the fine fraction exhibits plasticity are also classified as borderline and are given a dual symbol. Still another type of borderline classification is designated if the liquid limit of fine grain soil is less than 29 and the plasticity index lies in the range of four to seven.

ASTM Soil Classification System (Unified)

Major Divisions		Group Symbols	Typical Names	
Coarse-Grained Soils 50% or more retained on No. 200 sieve*	Sands and Clays Liquid limit 50% or less	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	
		GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	
		GM	Silty gravels, gravel-sand-silt mixtures	
		GC	Clayey gravels, gravel-sand-clay mixtures	
		SW	Well-graded sands and gravelly sands, little or no fines	
		SP	Poorly graded sands and gravelly sands, little or no fines	
		SM	Silty sands, sand-silt mixtures	
		SC	Clayey sands, sand-clay mixtures	
		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
Fine-Grained Soils 50% or more passes No. 200 sieve*		OL	Organic silts and organic silty clays of low plasticity	
Sands and Clays Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	
Highly Organic Soils		CH	Inorganic clays of high plasticity, fat clays	
		OH	Organic clays of medium to high plasticity	
		PT	Peat, muck, and other highly organic soils	

*Based on the material passing the 3-in. (75-mm.) sieve.

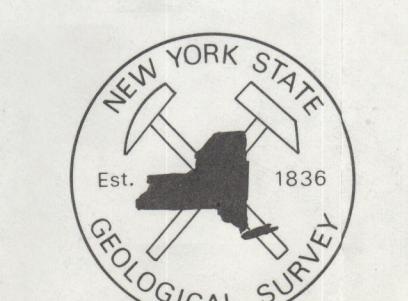


GEOLOGIC HAZARDS and THICKNESS OF OVERBURDEN of the ALBANY, NEW YORK 15 MINUTE QUADRANGLE

by

Robert H. Fickies and Peter T. Regan


Based Upon Geologic Mapping by Robert J. Dineen



LEGEND*

- 50' Isopach line - indicating approximate thickness of overburden in feet
- Hatched area - Area of bedrock at or near the surface
- Dotted area - Area having potential for sinkhole development
- Solid red area - Area having potential for landslides or other slope instability
- Light red area - Area having potential for wind erosion if stripped of surface cover

*Geological hazard units have been identified by using literature, test wells, field observations and comparison with similar units elsewhere. The purpose is to indicate potential problems which may be encountered in working with a particular unit as well as maximizing the chances for successful construction. This map is not a substitute for engineering geologic site investigation, which should be undertaken before any engineering design, construction, well-drilling, or mining venture is begun.

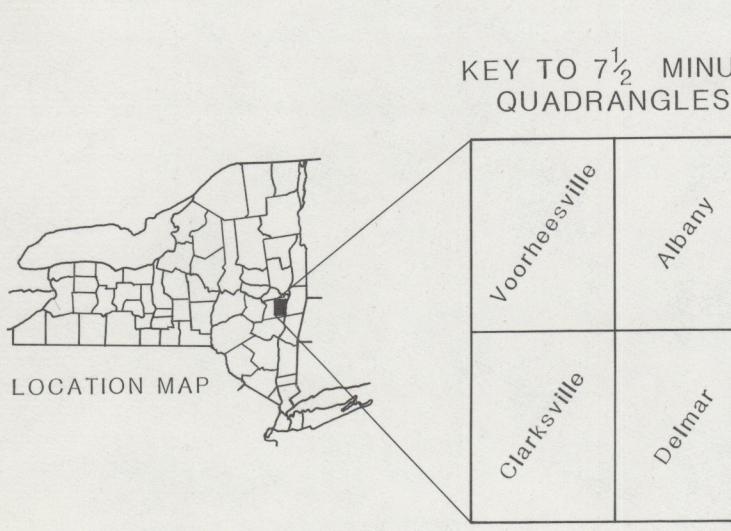


ENGINEERING GEOLOGY CLASSIFICATION of the SOILS of the ALBANY, NEW YORK 15 MINUTE QUADRANGLE

by

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Based Upon Geologic Mapping by Robert J. Dineen



SCALE
1:24,000
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0 .5 1.0 KILOMETER
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Fickies, Robert H. and Regan, Peter T.
New York State Museum and Science Service
Map and Chart Series 36
1982